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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filling a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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TITLE OF THE INVENTION (500 characters max)

SEAT FORCE SENSOR

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[X] Drawing(s) *Number of Sheets* 19 — [ ] Other (specify) ____

[ ] Application Data Sheet, See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

[ ] Applicant claims small entity status. See 37 CFR 1.27.

[X] A check or money order is enclosed to cover the filing fees

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REGISTRATION NO.: (if appropriate) 39,882
Docket Number: 8266-1075

USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT

PROVISIONAL APPLICATION COVER SHEET
Additional Page

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Docket Number	8266-1075

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Number 1 of 2

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Express Mail No.: EV 322399849 US

PROVISIONAL PATENT APPLICATION

of

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for

SEAT FORCE SENSOR

N1-14077

Attorney Docket No.: 8266-1075

SEAT FORCE SENSOR

Background and Summary of the Invention

The present invention relates to a weighing system for sensing a patient's weight when the patient is positioned on a patient support such as a hospital bed.

Some patients may be confined to a bed for extended periods of time making it difficult to weigh the patient on conventional weighing scales. Other patients may be wholly or partially disabled and unable to be positioned on a conventional weighing scale. The present invention provides a weighing system which can be added to or incorporated into a mattress and has the ability to accurately measure a patient's weight while the patient is positioned on the patient support. The weighing system can also provide the patient weight data to other systems, such as an air pressure controller for an inflatable mattress supporting the patient.

Brief Description of the Drawings

Fig. 1 is a side elevational view, in partial schematic, of a patient support;

Fig. 2 is a partially exploded side elevational view, in partial schematic, of an illustrative embodiment mattress assembly of the present invention;

Fig. 3 is a cross-sectional view, in partial schematic, taken along line 3-3 of Fig. 1 of an alternative embodiment mattress assembly;

Fig. 4 is a cross-sectional view, in partial schematic, similar to Fig. 3 of an alternative embodiment mattress assembly;

Fig. 5 is a cross-sectional view, in partial schematic, similar to Fig. 3 of an alternative embodiment mattress assembly;

Fig. 6 is a block diagram of an illustrative embodiment patient weighing system;

Fig. 7 is a flow chart showing an illustrative method of weighing a patient;

Fig. 8 is an illustrative chart of pressure versus pounds used for correlating the internal pressure of the seat force sensor with the approximate patient weight;

Fig. 9 is a block diagram of a further illustrative embodiment patient weighing system;

Fig. 10 is a flow chart showing another illustrative method of weighing a patient;

Fig. 11 is a flow chart showing a further illustrative embodiment of weighing a patient;

Fig. 12 is a cross-sectional view, in partial schematic, of an alternative embodiment patient support assembly;

Fig. 13 is a cross-sectional view, in partial schematic, of an alternative embodiment patient support assembly;

Fig. 14 is a partially exploded side elevational view, in partial schematic, of an illustrative embodiment weight sensor of the present invention;

Fig. 15 is a partially exploded side elevational view, in partial schematic, of a further illustrative embodiment weight sensor of the present invention;

Fig. 16 is a partially exploded side elevational view, in partial schematic, of an illustrative embodiment mattress assembly including the weight sensor shown in Fig. 15;

Fig. 17 is a cross-sectional view, in partial schematic, of an alternative embodiment mattress assembly including the weight sensor shown in Fig. 15;

Fig. 18 is a cross-sectional view, in partial schematic, of an alternative embodiment mattress assembly including the weight sensor shown in Fig. 15;

Fig. 19 is a cross-sectional view, in partial schematic, of an alternative embodiment mattress assembly including the weight sensor shown in Fig. 15;

Fig. 20 is a cross-sectional view, in partial schematic, of an alternative embodiment patient support assembly including weight sensors similar to the one shown in Fig. 15; and

Fig. 21 is a cross-sectional view, in partial schematic, of an alternative embodiment patient support assembly including the patient weight sensor shown in Fig. 15.

Detailed Description of the Drawings

Referring to Fig. 1, a patient support 2 including a frame 4, a deck 6, and an illustrative mattress assembly 10 is shown. The mattress assembly 10 may be utilized in connection with any type of conventional patient support 2, such as a hospital bed, a stretcher, etc. Referring now to Fig. 2, mattress assembly 10 illustratively includes a fluid mattress or support 12, a collector plate 16, a seat force sensor 18, and a base support 14. Fluid mattress 12 and base support 14 may include air bladders, foam

sections or any other suitable form of mattress material. In one illustrative embodiment, fluid mattress 12 includes at least one inflatable air bladder 19 having a head section 26, a seat section 22, and a foot section 24. The head section 26, seat section 22, and foot section 24 may be fluidly separated by walls 27. In one illustrative embodiment, base support 14 includes a hard foam material, while fluid mattress 12 includes a plurality of air bladders 19 such as those described in U.S. Patent Nos. 6,295,657 and 6,584,528, the disclosures of which are expressly incorporated by reference herein. In another illustrative embodiment, mattress 12 and base support 14 both comprise a foam material. More particularly, the air bladders 19 of the mattress 12 may be replaced with foam material.

As shown in Fig. 2, collector plate 16 is illustratively positioned above seat force sensor 18 and under the seat section 22 of fluid mattress 12. Collector plate 16 is configured to substantially support a patient's entire seat region to substantially focus and uniformly apply the patient's weight to seat force sensor 18. Collector plate 16 is illustratively made of metal, plastic, wood, foam, or any other suitable rigid or semi-rigid material. The collector plate 16 could also comprise an inflated air bladder. In one illustrative embodiment, seat force sensor 18 is a single air bladder placed under collector plate 16. Seat force sensor 18 can be any form of conventional air bladder, and its dimensions should be sufficiently long and wide enough so that the patient's sacral or seat region substantially covers the bladder area. Seat force sensor 18 may also include internal baffles 30 so it is able to maintain a predictable shape and volume as internal pressure increases. The air bladder thickness of the seat force sensor 18 is sufficiently thin so that the inflation of the air bladder will not be an annoyance to a patient positioned thereabove.

Referring now to Fig. 3, a further illustrative mattress assembly 10′, including seat force sensor 18, is shown. Fluid mattress or support 12′ is shown positioned on base support 14 of mattress assembly 10′. Mattress assembly 10′ is supported by deck 6 of patient support 2. In this embodiment, fluid mattress 12′ of the mattress assembly 10′ includes one or more air bladders 19. Seat force sensor 18 and collector plate 16 are positioned within air bladder 19 of fluid mattress 12. More particularly, seat force sensor 18 and collector plate 16 are positioned below the patient's sacral or

seat region while positioned within air bladder 19 of fluid mattress 12. In another illustrative embodiment, seat force sensor 18 is used without a collector plate 16.

In another alternative embodiment of mattress assembly 10″, as shown in Fig. 4, seat force sensor 18 is positioned on top of fluid mattress 12″. In this position, seat force sensor 18 is directly beneath a patient positioned on mattress assembly 10″. In yet another embodiment of mattress assembly 10‴, as shown in Fig. 5, base support 14′ includes a seat force sensor 18 which is positioned within the base support 14′. Collector plate 16 (not shown) could also be positioned inside base support 14′ above seat force sensor 18 in this embodiment. In addition to the embodiments described above, seat force sensor 18 may be removably coupled to existing mattresses or patient supports or incorporated in a fixed orientation into new patient supports.

Referring now to Fig. 6, a schematic of an illustrative embodiment operating system 31 including seat force sensor 18 is shown. A controller 33 is coupled to an air source, such as an air compressor 32, by signal line 40. If mattress assembly 10 is equipped with air compressor 32 configured to inflate the mattress 12, then such an air compressor 32 can also be used to inflate seat force sensor 18. Air compressor 32 is coupled to seat force sensor 18 by air line 42 which, in turn, is coupled to intake valve 36b. Intake valve 36b is coupled intermediate air line 42 and air line 44 to prevent undesired leakage of air from seat force sensor 18 through compressor 32. Exhaust valve 36a is coupled to seat force sensor 18 by air line 44 and includes an exhaust to the atmosphere 37. Controller 33 is coupled to exhaust valve 36a by signal line 46a, and is in communication with intake valve 36b through signal line 46b. A pressure transducer 38 is coupled to seat force sensor 18 by air line 48. Pressure transducer 38 is also coupled to controller 33 by signal line 50. A conventional flow restrictor (not shown) may be used as a flow control for the output of the air compressor 32.

One illustrative method of operating the system 31 to determine the approximate patient weight is based upon measuring the change in the pressure in seat force sensor 18 when it has been inflated with a known amount of air. For this method, the same amount of air is placed in seat force sensor 18 for all patients positioned on mattress assembly 10. The pressure of the bladder of seat force sensor 18 can then be measured and correlated with an experimentally determined look-up

table. For example, a pressure of 20 psi in seat force sensor 18 might correlate with a patient weighing 200 lbs., while a pressure of 17 psi might correlate with a patient weighing 180 lbs. Since the same amount of air is present in seat force sensor 18 for all patients, a higher pressure in seat force sensor 18 indicates a patient is heavier than a patient who creates a lower pressure in seat force sensor 18.

For the first step of this method, the bladder of seat force sensor 18 is first deflated or vented to atmosphere so the amount of air initially in the seat force sensor 18 is negligible. Next, a known volume of air is used to inflate the bladder of seat force sensor 18. This can be accomplished using air compressor 32 that outputs air at a known volumetric flow rate. The air compressor 32 is activated for a predetermined amount of time. In this method, the same amount of air is present in the seat force sensor 18 for each evaluation.

A flow chart 100 illustrating the steps of the illustrative method is shown in Fig. 7. To determine the patient's weight, seat force sensor 18 is positioned below the patient's sacral region in one of the manners detailed above. Pressure transducer 38 then measures the pressure in seat force sensor 18 and outputs a signal indicating the pressure to controller 33, as shown by step 102. Referring now to step 104, if the pressure in seat force sensor 18 is above a predefined pressure, for example, 0.2 psi, then controller 33 outputs a signal to valve 36a to deflate seat force sensor 18 until the pressure in seat force sensor 18 is below 0.2 psi, as shown by step 106. When the pressure in seat force sensor 18 is below the predetermined pressure, controller 30 sends a signal to valve 36a to close so that seat force sensor 18 can be inflated, as shown by step 108. Next, controller 33 actuates air compressor 32 to supply air to seat force sensor 18 for a predetermined amount of time, for example, 5 seconds, again as shown by step 108. It should be appreciated that other time intervals could be used and that the amount of time during which the air compressor 32 is activated determines the volume of air contained within the seat force sensor 18. After the air compressor has been active for the predetermined amount of time, and shuts down, pressure transducer 38 measures the pressure in seat force sensor 18 and outputs a signal indicative of the pressure to controller 33, as shown by step 110.

Referring now to step 112, controller 33 then correlates the pressure indicated by seat force sensor 18 with an approximate patient weight by using a lookup chart or table, such as that shown in Fig. 8, or by using a predetermined series of mathematical

equations or algorithms. The controller 33 then outputs the approximate patient weight to a display, as shown in step 114, and/or outputs the data to other bed features, such as a mattress air controller for an inflatable bladder 19 in fluid mattress 12, as shown by step 116. For example, as explained below, the mattress air controller can then use the patient weight data to select an appropriate pressure setting for fluid mattress 12. Other bed functions, such as a heel pressure relief air bladder and patient turn assist air bladders, may also use the patient weight data to make adjustments to their respective settings. More particularly, the patient weight data may be used to determine proper pressure settings for the heel pressure relief air bladder and the turn assist air bladders.

Referring further to Fig. 8, a chart indicating an approximate patient weight compared to the pressure in seat force sensor 18 is shown. Line 70 connecting data set 72 represent experimental values that have been determined based upon the air compressor 32 being activated for 5 second predetermined time periods. As noted above, other suitable time periods could be used.

Patients of different sizes require different pressure settings when positioned on inflatable mattresses to prevent pressure ulcers. One method of setting the appropriate pressure setting for an inflatable mattress 12 is for a healthcare provider to approximate or guess the patient's weight or reference the patient's last recorded weight and input this data into a controller which then adjusts the pressure in the inflatable mattress 12 for a patient of that weight based on a lookup table. According to the present invention, the optimum pressure setting for the inflatable mattress 12 may be determined automatically when a patient enters the bed 2 by determining the patient weight using the seat force sensor 18. As represented by step 116 in Fig. 7, inflatable mattress air controller can receive the patient weight data directly from controller 33 so the proper pressure setting may be selected.

The controller 33 also looks for a pressure change within the seat force sensor 18 at decision step 118. Upon detection of such a pressure change, an exit detection sub-routine is initiated at block 200, as detailed below. If no pressure change is detected at step 118, then the process continues at block 120 where the controller 33 controls valves 36a and 36b to hold air pressure in the seat force sensor 18. The pressure in the seat force sensor 18 is measured and the process then returns to decision step 118.

Referring now to Fig. 9, a schematic of an alternative embodiment operating system 35 is shown. In system schematic 35, controller 33 is coupled to valve 36 by signal line 52 and to air compressor 32 by signal line 58. Air compressor 32 is coupled to valve 36 by air line 56. Pressure transducer 38 is coupled to seat force sensor 18 by air line 62. Controller 33 is also coupled to pressure transducer 38 by signal line 60. Valve 36 is coupled to seat force sensor 18 by air line 54. Valve 36 includes an exhaust to atmosphere 37. In this illustrative embodiment, valve 36 receives air directly from air compressor 32 and controls air flow therefrom to seat force sensor 18, rather than air compressor 32 being directly connected to seat force sensor 18, as shown in the previous embodiment of Fig. 6.

To determine the approximate patient weight in connection with the system 35 of Fig. 9, the method illustrated in Fig. 7 is used with the exception of step 108. More particularly, an alternative step 108 is utilized in connection with system 35. When controller 33 actuates air compressor 32 to activate for a predetermined amount of time, controller 33 also actuates valve 36 to allow air to pass from air compressor 32 to seat force sensor 18. The remaining steps of the method, shown in Fig. 7, are substantially identical.

Referring now to Fig. 10, associated with the systems 31 and 35 of the present invention is a method for detecting when a patient has exited the mattress 12 or when the patient or a different patient enters or exits mattress 12. Referring back to Fig. 7, reevaluation of seat force, as shown by step 118, occurs when a pressure change is detected in the seat force sensor 18, for example, due to a patient's change of status such as exiting, entering, or repositioning in the bed. Referring to Figs. 6 and 7, controller 33 monitors the pressure in seat force sensor 18 by receiving input from the pressure transducer 38.

In one illustrative embodiment, as shown in Fig. 10, method 200 may be considered a subroutine or subprocess which is activated after step 118 of method 100 in Fig. 7, if the pressure changes in seat force sensor 18. Method 200 includes the step of measuring the pressure (P) in the seat force sensor 18 in step 202. If the pressure in seat force sensor 18 drops below a predetermined level (X1) or rises above a predetermined level (X2) as shown by step 204, the process 200 returns to measuring step 102 of Fig. 7, as shown by block 208. If not, the pressure in the seat force sensor 18 is again monitored for change.

In another illustrative embodiment, shown in Fig. 11, method 220 is similar to method 200 in that it also monitors the pressure in the bladder at step 222. If the pressure drops to less than a predetermined level of pressure (X1) or rises above a predetermined level (X2) in step 224, a one hour timer activates in step 226 and returns to the measuring step 102 of Fig. 7 after the hour has passed, as shown by step 228. As may be appreciated, any suitable time period may be used. If mattress assembly 10 includes an inflatable mattress 12, this method assumes that pressure ulcers will not form on the patient within a one hour time period if a new patient has entered mattress assembly 10 and the pressure in the air mattress 12 is not correctly set for the new patient. The one hour time period can be adjusted based on the patient's specific needs.

Other methods of correlating the approximate patient weight with data from the seat force sensor 18 may be used. For example, the seat force sensor 18 could be inflated to a predetermined pressure and then inflated or deflated to a predetermined pressure while the time period of inflation or deflation is measured. The change in time could then be used to correlate with the approximate patient weight. Another method may include the steps of measuring an initial pressure of the seat force sensor 18 and activating the air compressor 32 to inflate or deflate the air bladder of the seat force sensor 18 until a predetermined volume of the air bladder is achieved. The amount of time or the change in pressure could then be used to correlate with the approximate patient weight. To use this method, the volume metric flow rate of the air compressor 32 would be required. If the amount of air flow out of the air compressor 32 is not predictable or is difficult to determine, the flow can be measured with a flow meter/transducer.

In a further illustrative embodiment of the present invention shown in Fig. 12, an adjustable patient support 300 is shown. Patient support 300 includes at least a head section 302 and a seat section 304. Head section 302 can be elevated to raise a patient positioned on patient support 300 to a sitting position. In this embodiment, mattress assembly 10′ is placed on seat section 304 and a second mattress assembly 306 is placed on head section 302. Mattress assembly 306 is identical to mattress assembly 10′, except that it is positioned on head section 304. Mattress assembly 306 includes a back force sensor 310 and may include a collector plate 312. The back

force sensor 310 is substantially identical to the seat force sensor 18, while the collector plate 312 is substantially identical to the collector plate 16. More particularly, the method of operation for back force sensor 310 is the same method used to operate seat force sensor 18. Utilizing back force sensor 310 and seat force sensor 18 allows a patient positioned on patient support 300 to be weighed even when head section 302 is elevated as illustrated in Fig. 12. A controller can compare the pressures in seat force sensor 18 and back force sensor 310 to a look-up table to determine the patient's weight. Alternatively, the values from the seat force sensor 18 and back force sensor 310 may be used in algorithms to determine the patient's weight and position.

It should be noted that the change of pressure detected by the seat force sensor 18 of the previous illustrated embodiments may be replaced with a change of pressure detected by the back force sensor 310 to trigger a measurement cycle.

In an alternative embodiment of Fig. 12, back force sensor 310 and collector plate 312 are not present in mattress assembly 306. Angle sensor 320 is coupled to patient support 300 as shown in Fig. 13 to determine the angle A of inclination or declination of head section 302 relative to seat section 304 and output a signal indicative of the angle A to a controller. The controller then compares the angle A and the pressure in seat force sensor 18 to a look-up table to determine the approximate patient weight. Again, an algorithm may be substituted for the look-up table. The weight of a patient positioned on patient support 300 can be determined even if head section 302 is inclined or declined relative to seat section 304.

It should be noted that a seat force sensor 18 (Figs. 12 and 13) may be used in combination with a back force sensor 310 (Fig. 12) and an angle sensor 320 (Fig. 13) to determine a patient weight distribution having improved accuracy (i.e. detection of a patient sitting up).

An alternative embodiment of seat force sensor 18 is shown in Fig. 14. Seat force sensor 400 includes an upper plate 402, a lower plate 404, a plurality of weight sensors 406, wires 408, and a controller 410. Upper plate 402 and lower plate 404 are similar to collector plate 16 and are also used to concentrate the patient's weight uniformly on the weight sensors 406. Both plates 402 and 404 are illustratively made of metal, plastic, wood, or any other suitable rigid or semi-rigid material. Plates 402 and 404 are sized to support the patient's sacral or seat region.

Weight sensors 406 are positioned between plates 402 and 404 and produce an electrical signal that is proportional to the force applied to them. Weight sensors 406 may include force transducers such as force sensing resistor pads, load cells, resistive ink-type transducers such as FLEXIFORCE by TEKSCAN, or any other suitable force transducer. Any number of weight sensors may be used in seat force sensor 400. If more weight sensors 406 are used in seat force sensor 400, smaller load cells having better accuracy can be used which could improve the overall accuracy of seat force sensor 400. If a smaller number of load cells are used the capacity of each load cell must be greater and as a result, the accuracy of each load cell is lower which lowers the overall accuracy of seat force sensor 400.

The plurality of weight sensors 406 are connected to controller 410 by wires 408. In the illustrated embodiment five weight sensors are used. Seat force sensors configured to weigh larger patients may require more weight sensors 406. Controller 410 receives the electrical signals via wires 408 from each weight sensor 406. Controller 410 then correlates the signals received from weight sensor 406 with an approximate patient weight by using a look-up chart or table similar to that shown in Fig. 8 or by using a predetermined series of mathematical equations or algorithms. Controller 410 then outputs the approximate patient weight to a display and/or outputs the data to other bed features, such as a mattress air controller for an inflatable bladder in a fluid mattress. As explained above, the mattress air controller can then use the patient weight data to select an appropriate pressure setting for a fluid mattress. Other bed functions, such as a heel pressure relief air bladder and patient turn assist air bladders, may also use the patient weight data to make adjustments to their respective settings.

An alternative embodiment of seat force sensor 400′ is shown in Fig. 15. Seat force sensor 400′ is similar to seat force sensor 400 with the exception of upper plate 402′ and standoffs 412. Upper plate 402′ includes a plurality of standoffs 412, each positioned directly over one of the plurality of weight sensors 406, which are mounted on lower plate 404. Seat force sensor 400′ includes a standoff 412 for each corresponding weight sensor 406. Standoffs 412 focus the weight of the patient on the weight sensors 406 to provide a more accurate patient weight. The electrical signals from the weight sensors 406 are carried to controller 410 through wires 408.

Any number of weight sensors 406 and standoffs 412 could be used in seat force sensor 400′. For illustration, five weight sensors 406 are shown in Fig. 15.

As shown in Fig. 16, seat force sensor 400′ is illustratively positioned in the same orientation as seat force sensor 18, shown in Fig. 2. Upper plate 402′ is configured to substantially support a patient's entire seat region and to substantially focus and uniformly apply the patient's weight to seat force sensor 400′. As discussed above, upper plate 402′ is similar to collector plate 16 and is configured to focus the force of the patient's weight uniformly upon standoffs 412, which in turn apply pressure to weight sensors 406. When the patient is positioned on mattress assembly 10a, upper plate 402′ is depressed which causes standoffs 412 to apply pressure to weight sensors 406 to generate electrical signals proportional to the force applied to them. Controller 410 (not shown) receives the electrical signals and correlates them to an approximate patient weight and outputs the patient weight to a display and/or other bed features such as a heel pressure relief system or a patient turn assist system.

Referring now to Fig. 17, a further illustrative mattress assembly 10b similar to mattress assembly 10′, shown in Fig. 3, is shown. Fluid mattress or support 12b is shown positioned on base support 14 of mattress assembly 10b. In this embodiment, fluid mattress 12b of mattress assembly 10b includes seat force sensor 400′. Seat force sensor 400′ is positioned within air bladder 19 of fluid mattress 12b. More particularly, seat force sensor 400′ is positioned below the patient's sacral or seat region while positioned within air bladder 19 of fluid mattress 12b.

In another alternative embodiment of mattress assembly 10c, as shown in Fig. 18, seat force sensor 400′ is positioned on top of fluid mattress 12c similar to the embodiment shown in Fig. 4. In this position, seat force sensor 400′ is directly beneath a patient positioned on mattress assembly 10c. The patient's sacral region contacts upper plate 402′ and forces standoffs 412 downward applying pressure to weight sensors 406.

In yet another embodiment of mattress assembly 10d, as shown in Fig. 19, base support 14a includes a seat force sensor 400′ which is positioned within the base support 14a which is supported by frame 6. In addition to the embodiments described

above, seat force sensor 400 may be removably coupled to existing mattresses or patient supports or incorporated in a fixed orientation into new patient supports.

In a further illustrative embodiment of the present invention shown in Fig. 20, an adjustable patient support 300a is shown. Patient support 300a is similar to patient support 300 shown in Fig. 12. Seat force sensors 18 have been replaced by seat force sensors 400′. Patient support 300a includes at least a head section 302a and a seat section 304a. Head section 302a can be elevated to raise a patient position on patient support 300a to a sitting position. In this embodiment, mattress assembly 10b is placed on seat section 304a and a second mattress assembly 306a is placed on head section 302a. Mattress assembly 306a is identical to mattress 10b, except that it is positioned on head section 304a. Mattress assembly 306a includes a back force sensor 400′. Back force sensor 400′ is substantially identical to the seat force sensor 400′. More particularly, the method of operation of back force sensor 400′ is the same method used to operate seat force sensor 400′. Utilizing back force sensor 400′ and seat force sensor 400′ allows a patient positioned on patient support 300a to be weighed even when the head section 302a is elevated as illustrated in Fig. 20. A controller can compare the electrical signals received from weight sensors 406 of seat force sensor 400′ and back force sensor 400′ to a look-up table to determine the patient's weight or head angle. Alternatively, the electrical signals from seat force sensor 400′ and back force sensor 400′ may be used in algorithms to determine a patient's weight.

Fig. 21 illustrates an alternative embodiment of Figs. 13 and 20, wherein back force sensor 400′ is not present in mattress assembly 306b. Angle sensor 320 is coupled to patient support 300b as shown in Fig. 21 to determine the angle A of inclination or declination of head section 302b relative to seat section 304b. Sensor 320 outputs a signal indicative of the angle A to a controller. The controller then compares the angle A and the electrical signals received from seat force sensor 400′ to a look-up table to determine the approximate patient weight. Again, an algorithm may be substituted for the look-up table. The weight of the patient positioned on patient support 300b can be determined even if head section 302b is inclined or declined relative to seat section 304b.

The foregoing description of the invention is illustrative only, and is not intended to limit the scope of the invention to the precise terms set forth. Although the invention has been described in detail with reference to certain illustrative embodiments, variations and modifications exist within the scope and spirit of the invention as described and defined in the following claims.

Claims:

1. A patient support comprising:

a frame;

a deck supported by the frame;

a mattress supported by the deck;

an inflatable cell operatively coupled to the mattress and configured to contain a fluid;

an air source configured to inflate the inflatable cell;

a pressure sensor configured to measure a pressure of the fluid in the inflatable cell; and

a controller coupled to the pressure sensor and the air source, the controller configured to determine a weight of a patient positioned on the patient support, and control the air source in response thereto.

2. The patient support of claim 1, wherein the inflatable cell is positioned below the mattress.

3. The patient support of claim 1, wherein the mattress includes a foam material.

4. The patient support of claim 1, wherein the mattress includes at least one inflatable bladder.

5. The patient support of claim 4, wherein the inflatable cell is positioned within the at least one inflatable bladder of the mattress.

6. The patient support of claim 1, wherein the mattress includes a head section, a seat section, and a foot section and the inflatable cell is positioned within the seat section.

7. The patient support of claim 1, wherein the mattress includes a head section, a seat section, and a foot section and the inflatable cell is positioned under the seat section.

8. The patient support of claim 1, further comprising a collector plate wherein the inflatable cell is placed below the collector plate.

9. The patient support of claim 1, wherein the mattress includes a first section and a second section positioned under the first section.

10. The patient support of claim 1, wherein the inflatable cell is positioned between the first and second mattress sections.

11. The patient support of claim 10, wherein the first and second mattress sections include a foam material.

12. The patient support of claim 4, wherein the controller is configured to adjust a pressure of the at least one inflatable bladder.

13. The patient support of claim 13, wherein the controller is configured to adjust the pressure of the at least one inflatable bladder based upon the patient's weight.

14. The patient support of claim 14, wherein the controller is configured to automatically adjust the pressure of the at least one inflatable bladder after determining the patient's weight.

15. The patient support of claim 1, further comprising a display configured to display the patient's weight.

16. A weight sensor configured to measure the weight of a patient positioned on a patient support, the weight sensor comprising:

an inflatable cell configured to contain a fluid;

a pressure sensor configured to measure a pressure of the fluid in the inflatable cell; and

a controller configured to receive a pressure signal from the pressure sensor and determine the weight of the patient supported on the patient support based on the pressure signal.

17. The patient support of claim 17, wherein the fluid is air.

18. The patient support of claim 17, wherein an air compressor is configured to supply fluid to the inflatable cell.

19. The patient support of claim 19, wherein the controller is configured to control the air compressor.

20. The patient support of claim 20 further comprising a flow transducer configured to measure an output of air from the air compressor.

21. The patient support of claim 17, wherein the controller is configured to output the weight of the patient to a display.

22. The patient support of claim 17, wherein the controller is configured to output the weight of the patient to a second controller configured to control the inflatable mattress and an inflatable mattress is positioned on the patient support.

23. A method of determining a weight of a patient positioned on a patient support, the patient support including a frame, an inflatable mattress positioned on the frame, the method comprising the steps of:

providing an inflatable cell adjacent to the mattress, a pressure sensor coupled to the inflatable cell and configured to measure a pressure inside the inflatable cell, and a controller configured to receive input from the pressure sensor,

measuring the pressure inside the inflatable cell;

deflating the inflatable cell to a predetermined pressure;

inflating the inflatable cell for a predetermined time period; and

measuring the pressure in the inflatable cell.

24. The method of claim 23, further comprising the step of comparing the measured pressure of the inflatable cell with a comparison table.

25. The method of claim 24, further comprising the step of determining the weight of the patient positioned on the patient support based on the measured pressure.

26. An apparatus including:

an inflatable mattress;

an inflatable bladder;

a pressure sensor coupled to the inflatable bladder and configured to output a signal indicative of the pressure in the inflatable bladder; and

a controller configured to receive the signal and control the pressure in the inflatable mattress based on the signal.

27. A method of detecting when a patient has exited a patient support, the method including the steps of:

providing a patient support including a mattress and an inflatable cell;

monitoring the pressure in the inflatable cell; and

actuating a signal when the pressure in the inflatable cell drops.

28. A patient support comprising:

a frame;

a deck supported by the frame;

a mattress supported by the deck;

a weigh system positioned adjacent the mattress and configured to determine a weight of a patient positioned on the mattress, the weigh system including first and second rigid plates separated by a plurality of weight sensors, the weight sensors configured to output a signal indicative of the weight of the patient positioned on the mattress; and

a processor configured to receive the signal and compare the signal to a comparison table to determine the weight of the patient.

29. The patient support of claim 28, wherein the weigh system is positioned above the mattress.

30. The patient support of claim 28, wherein the weigh system is positioned below the mattress.

31. The patient support of claim 28, wherein the mattress includes a foam material.

32. The patient support of claim 28, wherein the weight sensors are load cells.

33. The patient support of claim 28, wherein the weight sensors are force transducers.

34. The patient support of claim 28, wherein the weight sensors are force sensing resistor pads.

35. The patient support of claim 28, wherein the mattress includes a head section, a seat section, and a foot section, the seat section including a first inflatable cell, the weigh system positioned within the first inflatable cell.

36. The patient support of claim 35, wherein the head section includes a second inflatable cell, a second weigh system positioned within the second inflatable cell.

37. A patient support comprising:

a frame;

a deck supported by the frame;

a mattress supported by the deck;

a weigh system positioned below the mattress and configured to determine a weight of a patient positioned on the mattress, the weigh system including first and second rigid plates each including an upper and lower surface, the lower surface of the first plate including a plurality of standoffs coupled thereto, the upper surface of the second plate including a plurality of weight sensors coupled to the upper surface at positions perpendicular to the plurality of standoffs, the first plate configured to rest on top of the second plate, the sensors configured to output a signal indicative of the weight of the patient positioned on the mattress; and

a processor configured to receive the signal, the processor configured to determine the weight of the patient in response to the signal.

38. The patient support of claim 37, wherein the mattress includes a foam material.

39. The patient support of claim 37, wherein the weight sensors are load cells.

40. The patient support of claim 37, wherein the weight sensors are force transducers.

41. The patient support of claim 37, wherein the weight sensors are force sensing resistor pads.

42. The patient support of claim 37, wherein the mattress includes a head section, a seat section, and a foot section, the seat section including a first inflatable cell, the weigh system positioned within the first inflatable cell.

43. The patient support of claim 42, wherein the head section includes a second inflatable cell, a second weigh system positioned within the second inflatable cell.

ABSTRACT

A weighing system associated with a mattress and configured to measure a patient's weight while the patient is positioned on the mattress.

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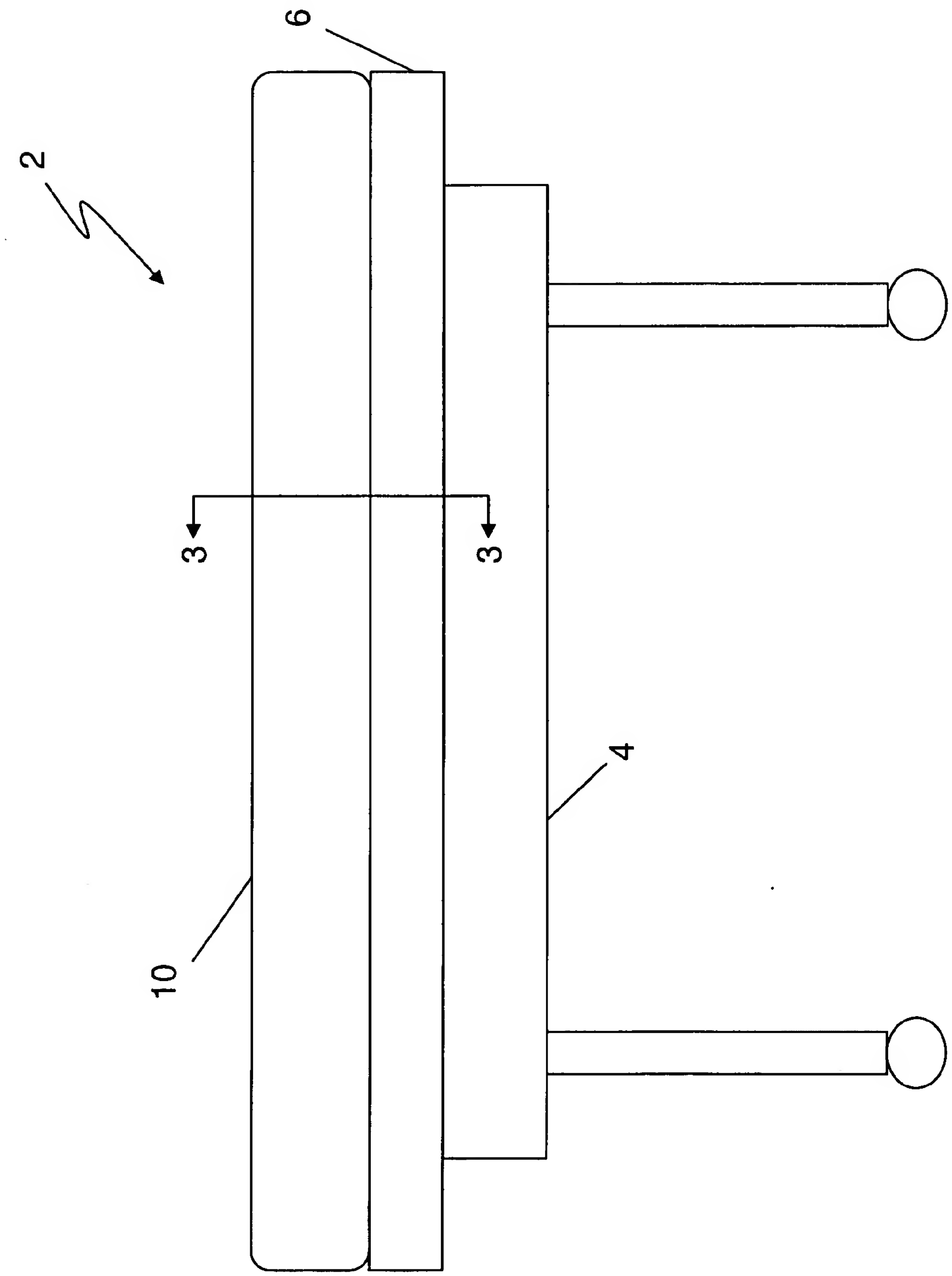

FIG. 1

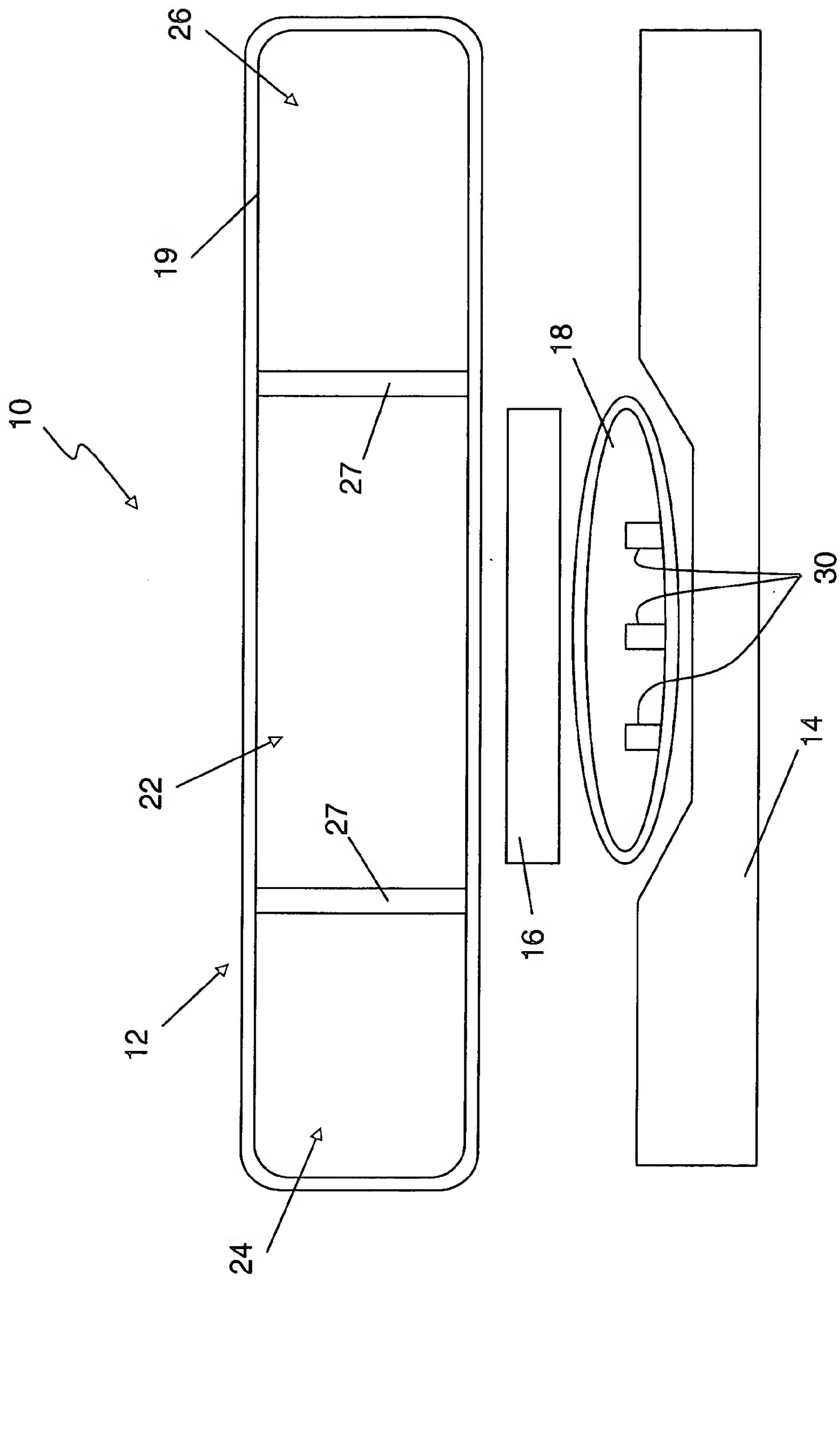

FIG. 2

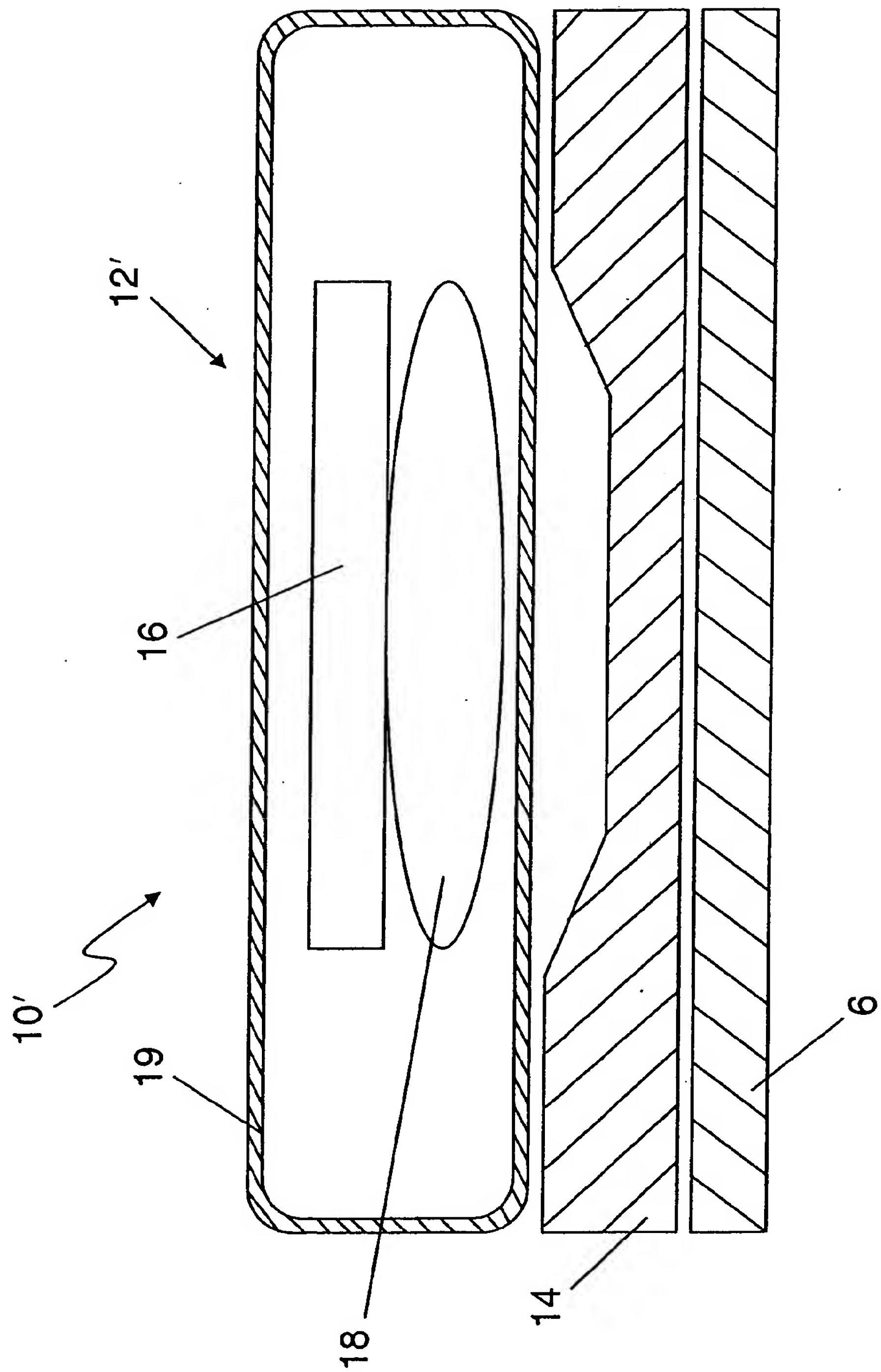

FIG. 3

SEAT FORCE SENSOR
Inventors: Andrew F. Skinner et al.
Serial No.: Unknown
Attorney Docket: 8266-1075
Sheet 4 of 19

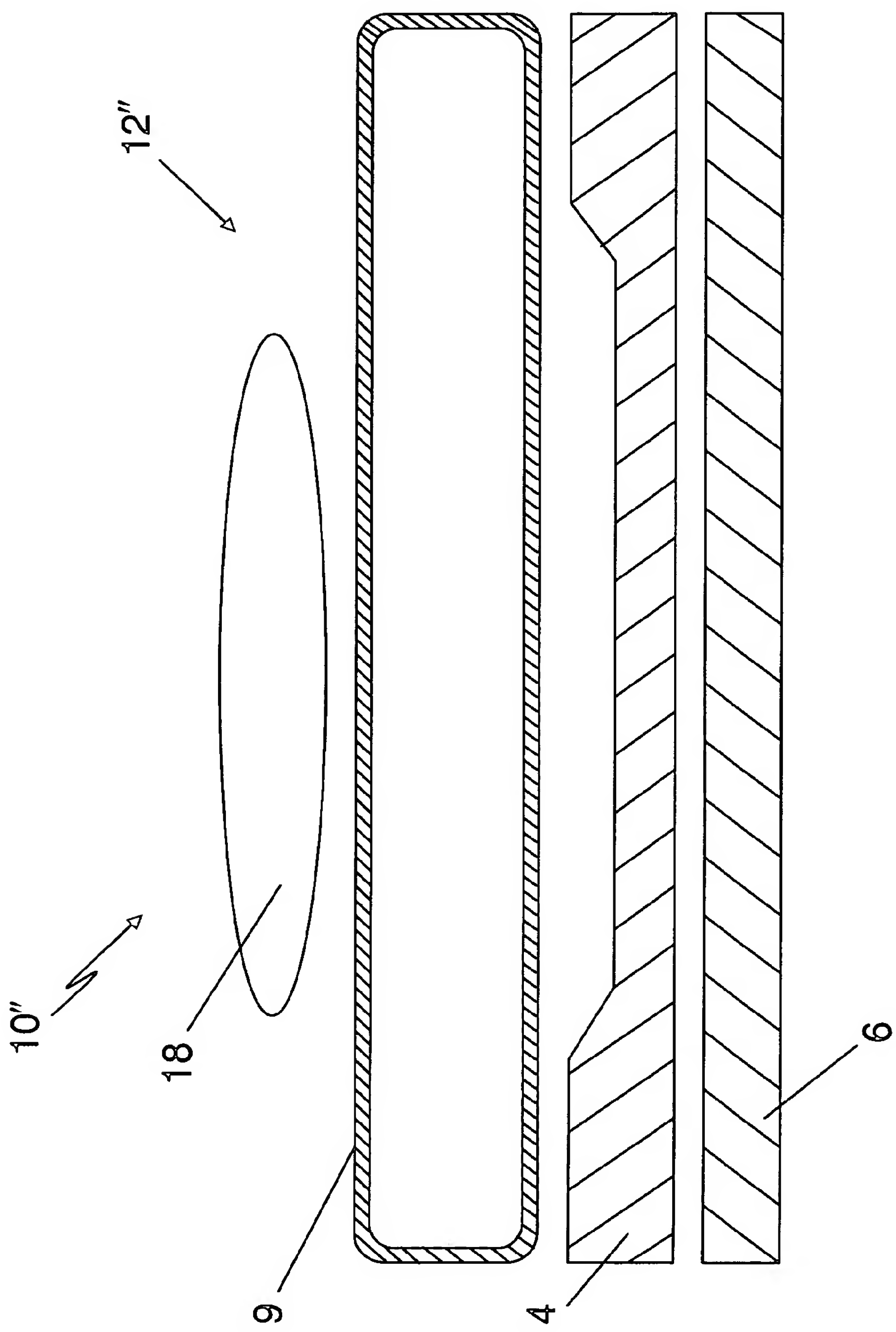

FIG. 4

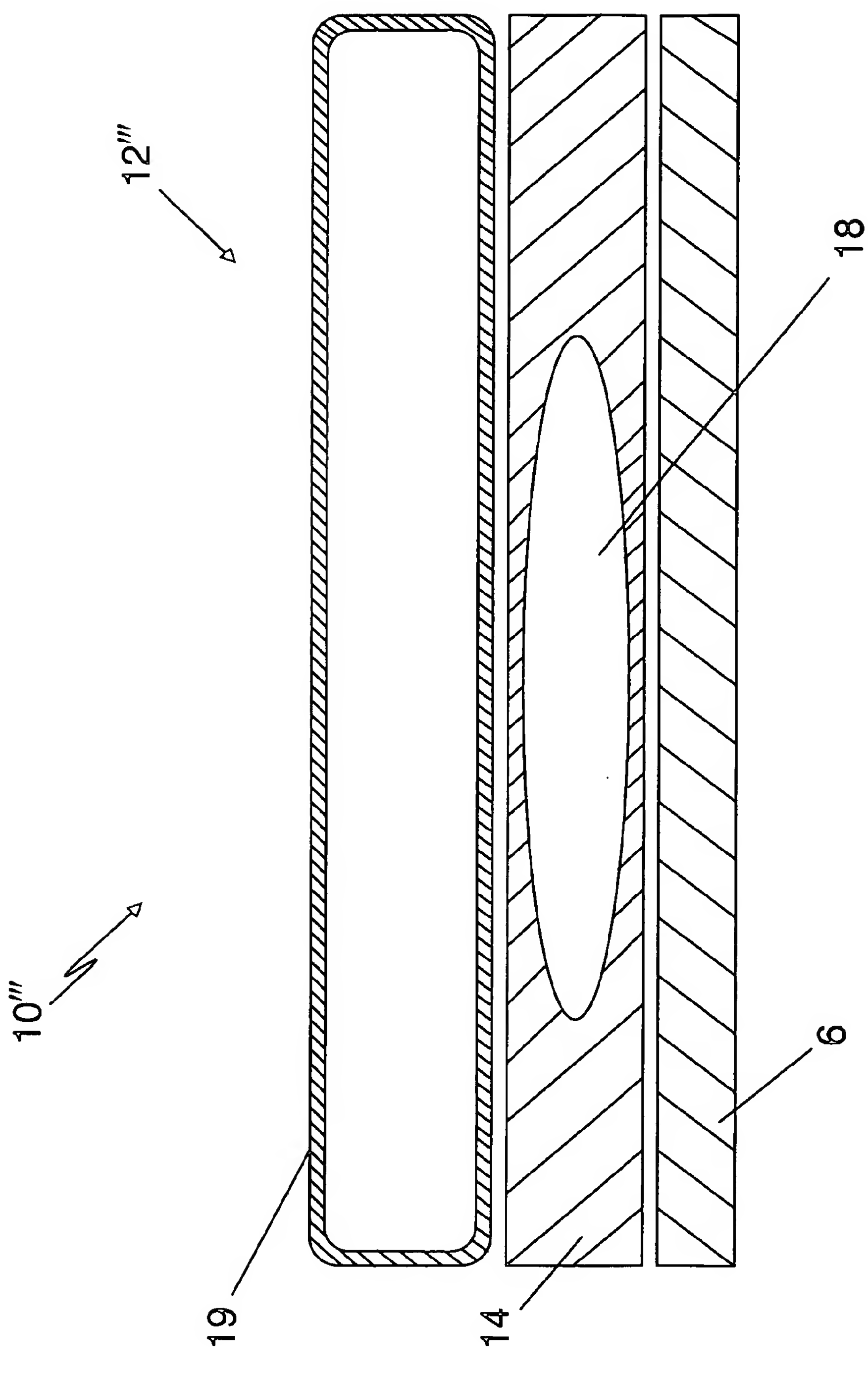

FIG. 5

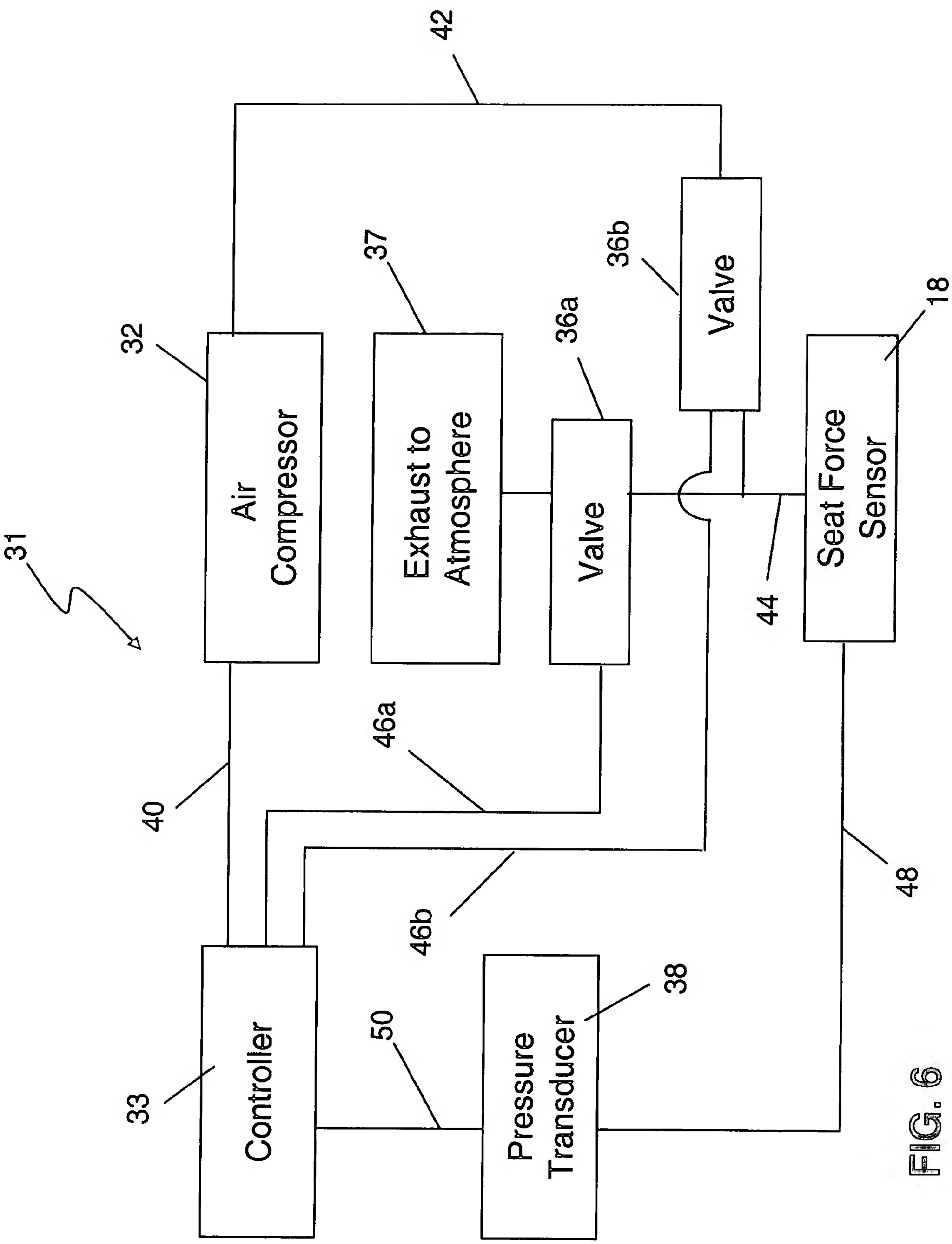
31
32
Air Compressor
37
Exhaust to Atmosphere
36a
Valve
36b
Valve
42
18
Seat Force Sensor
44
40
46a
46b
48
33
Controller
50
Pressure Transducer
38

FIG. 6

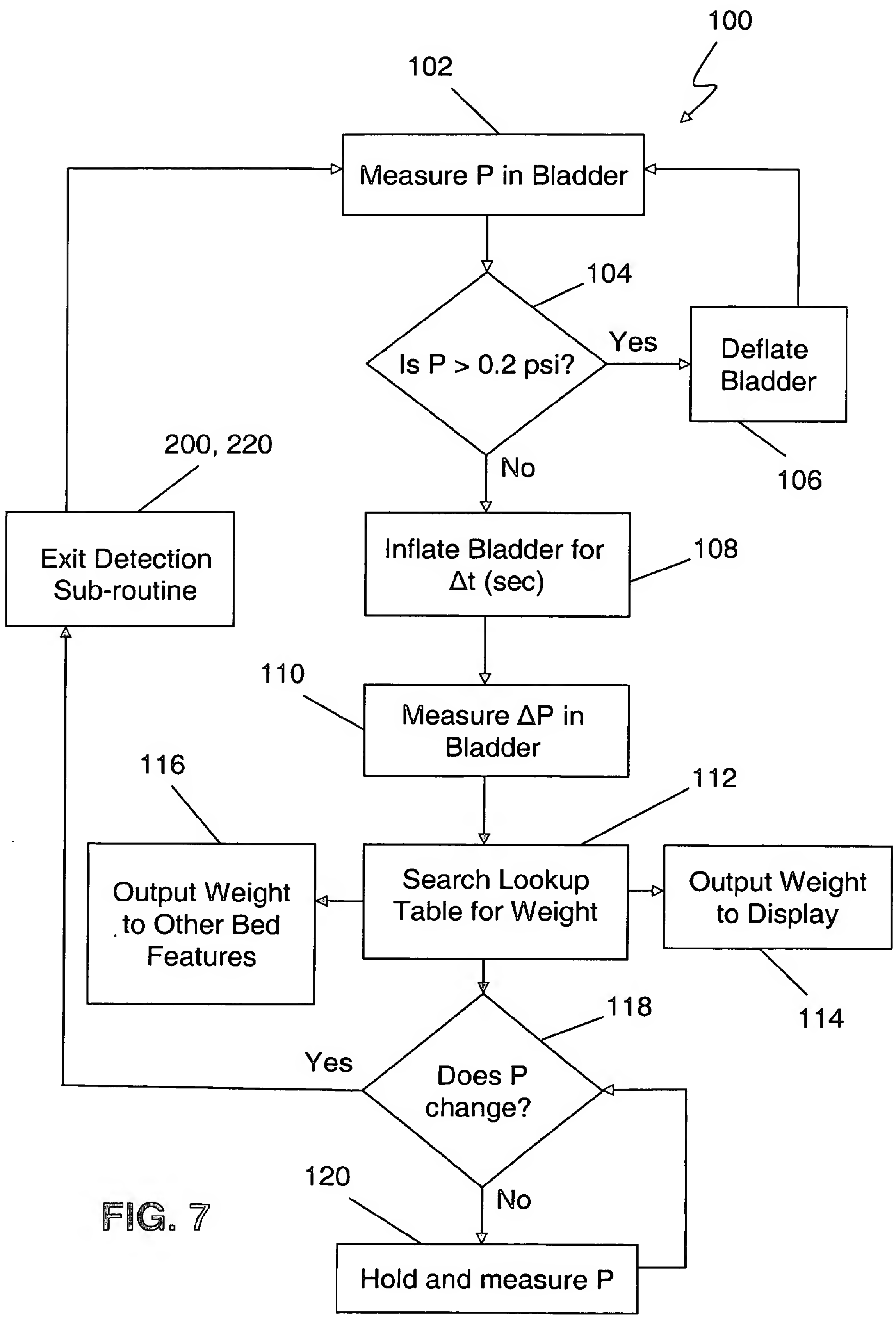
100
102
Measure P in Bladder
104
Is P > 0.2 psi?
Yes
Deflate Bladder
106
No
200, 220
Exit Detection Sub-routine
Inflate Bladder for Δt (sec)
108
110
Measure ΔP in Bladder
116
112
Output Weight to Other Bed Features
Search Lookup Table for Weight
Output Weight to Display
114
118
Yes
Does P change?
120
No
Hold and measure P

FIG. 7

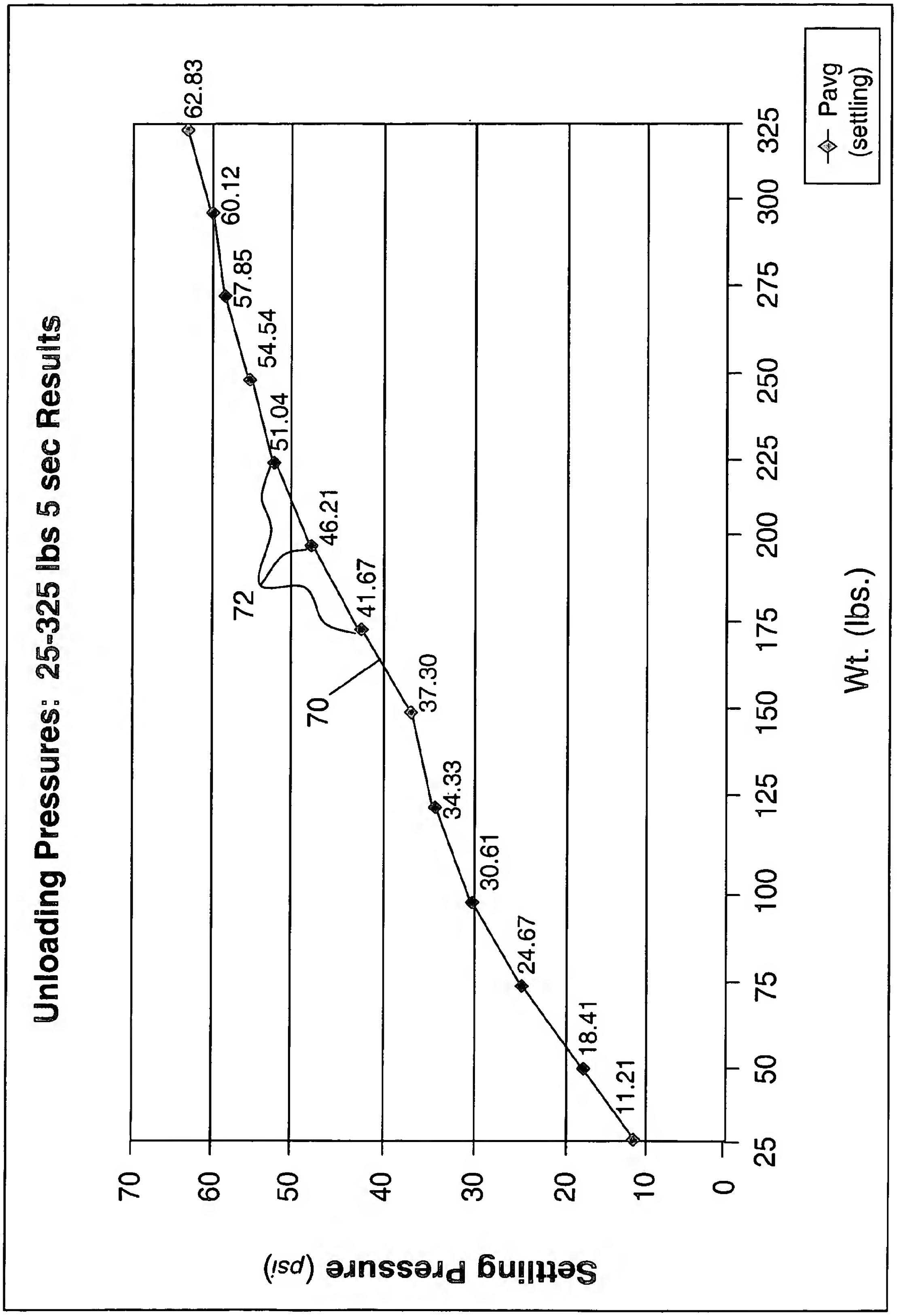
Unloading Pressures: 25-325 lbs 5 sec Results
Settling Pressure (psi)
0
10
20
30
40
50
60
70
25
50
75
100
125
150
175
200
225
250
275
300
325
Wt. (lbs.)
11.21
18.41
24.67
30.61
34.33
37.30
41.67
46.21
51.04
54.54
57.85
60.12
62.83
70
72
Pavg (settling)

FIG. 8

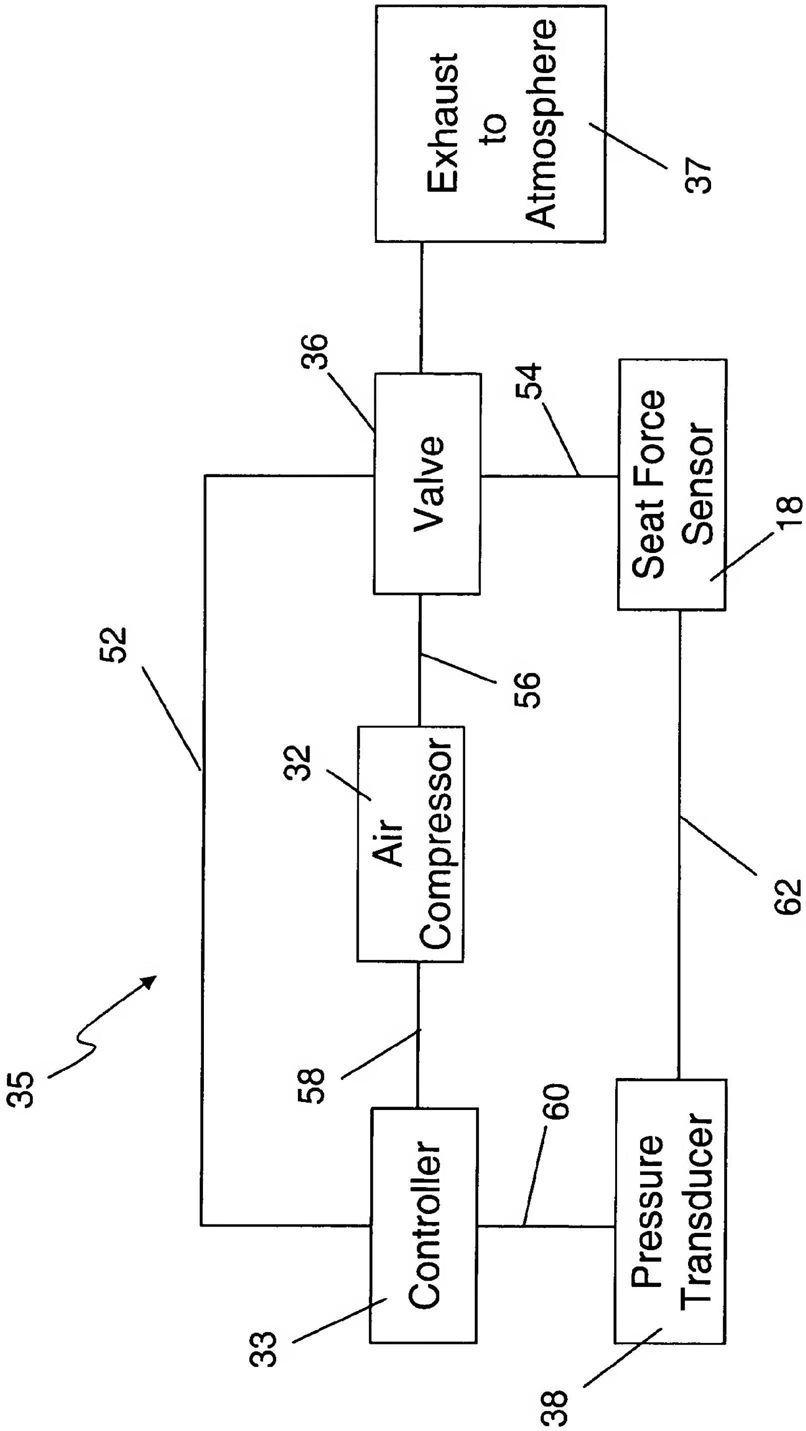
Exhaust to Atmosphere
37
36
Valve
54
Seat Force Sensor
18
52
56
32
Air Compressor
62
35
58
60
Controller
Pressure Transducer
33
38

FIG. 9

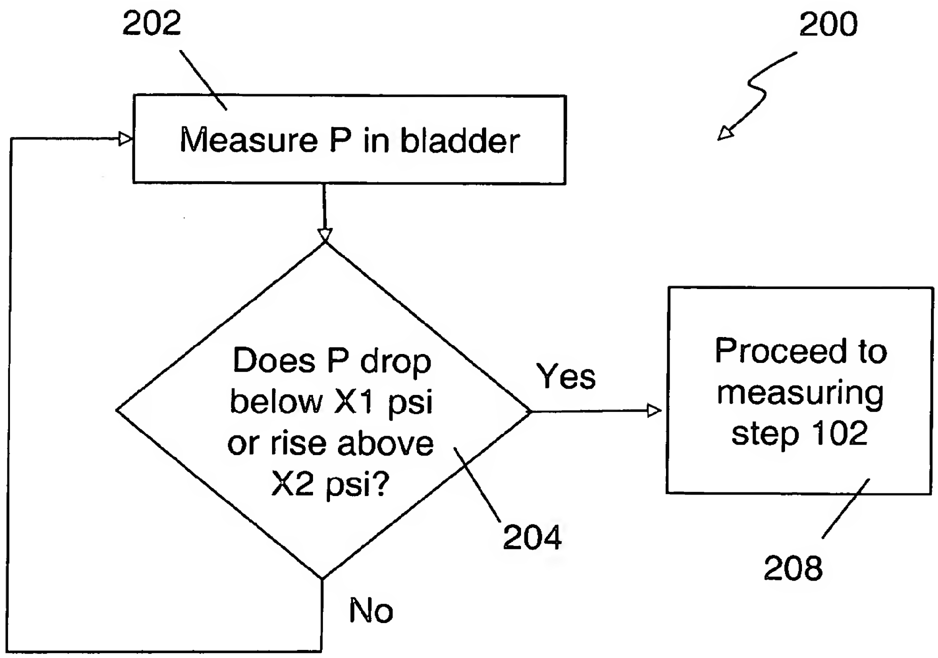
202
200
Measure P in bladder
Does P drop below X1 psi or rise above X2 psi?
Yes
Proceed to measuring step 102
204
208
No

FIG. 10

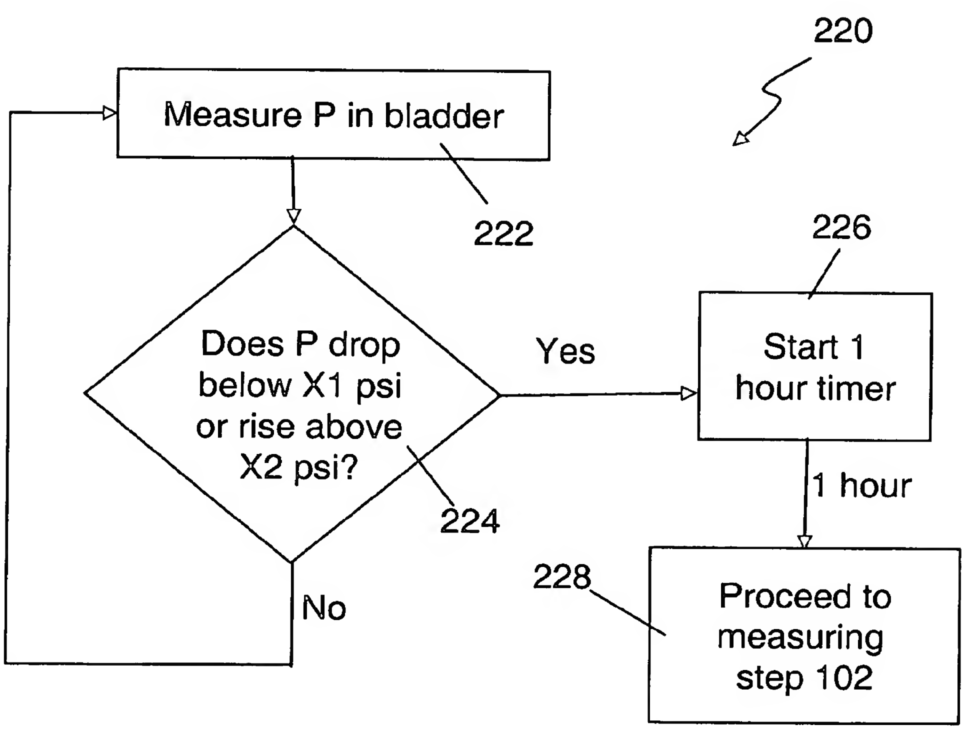
220
Measure P in bladder
222
226
Does P drop below X1 psi or rise above X2 psi?
Yes
Start 1 hour timer
1 hour
224
228
Proceed to measuring step 102
No

FIG. 11

SEAT FORCE SENSOR
Inventors: Andrew F. Skinner et al.
Serial No.: Unknown
Attorney Docket: 8266-1075

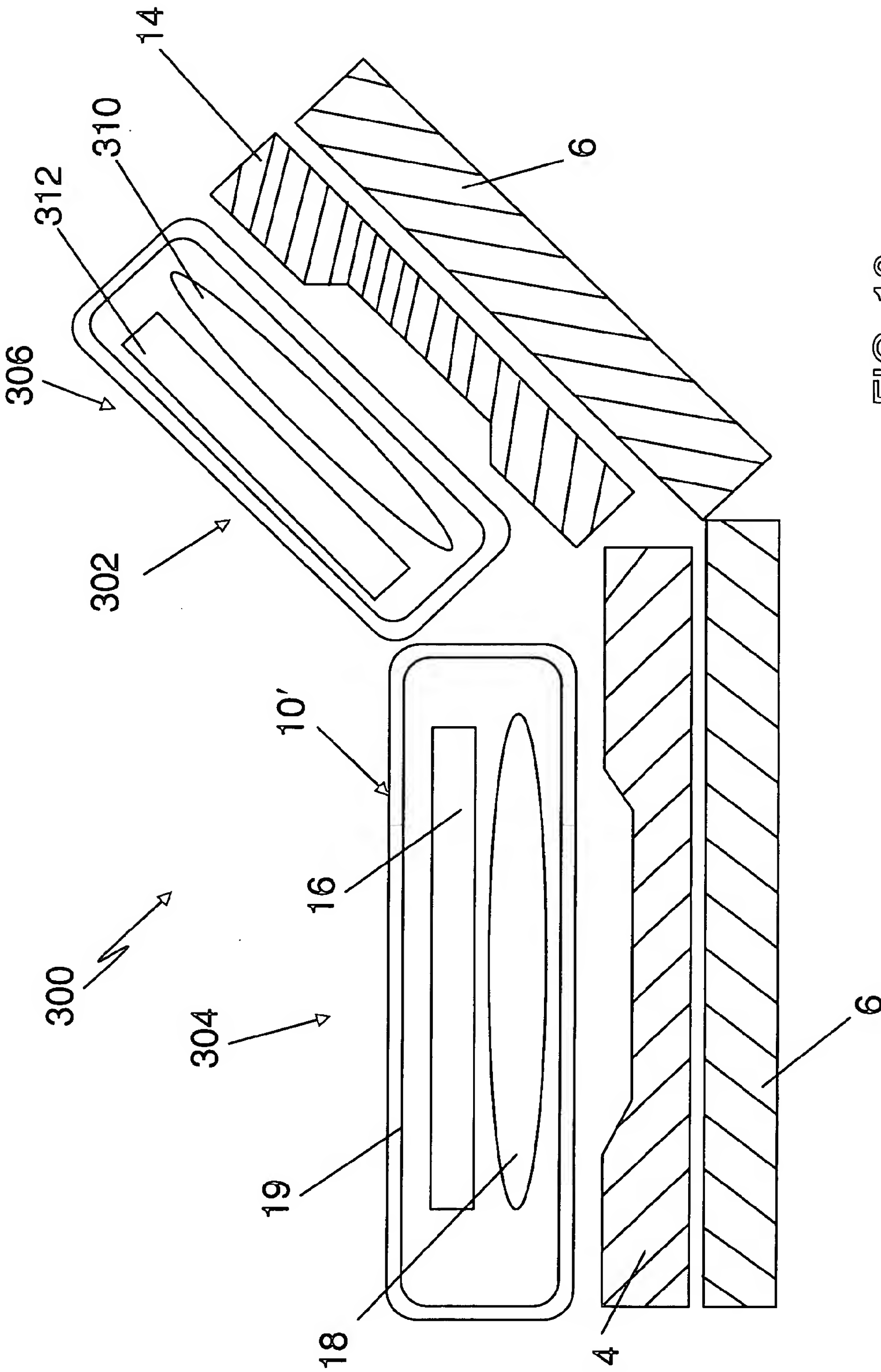

FIG. 12

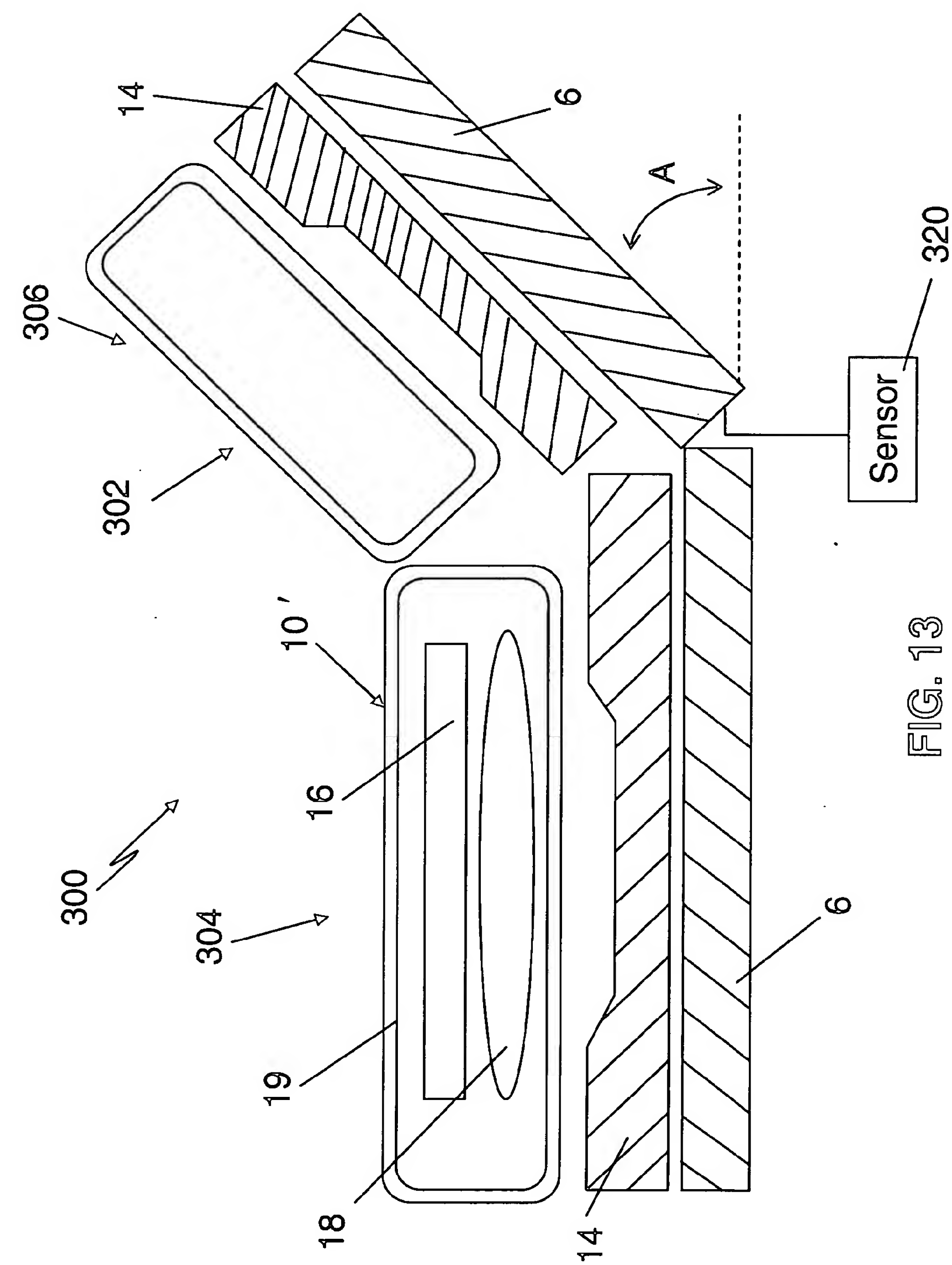

FIG. 13

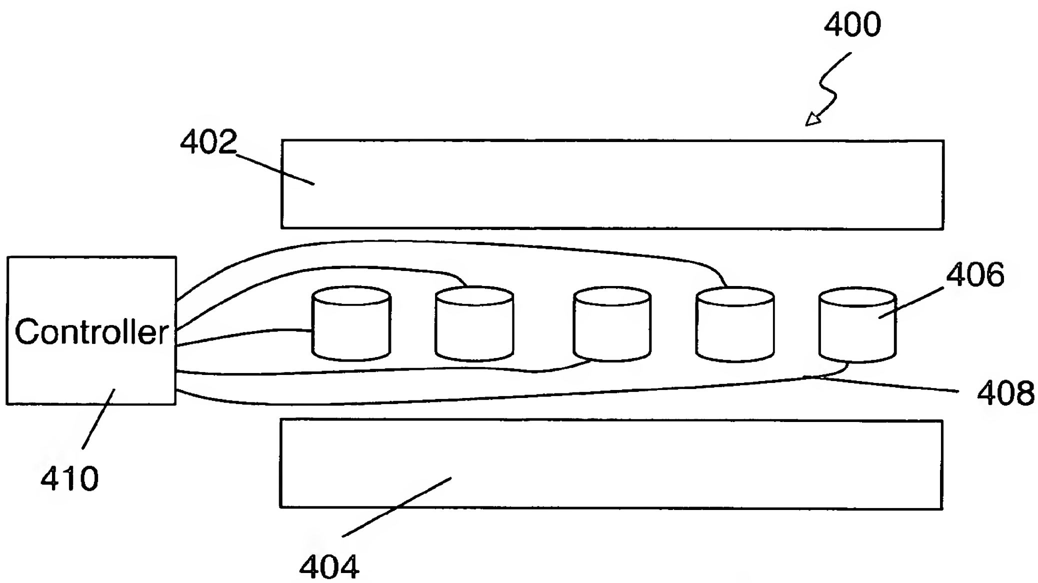
400
402
Controller
406
408
410
404

FIG. 14

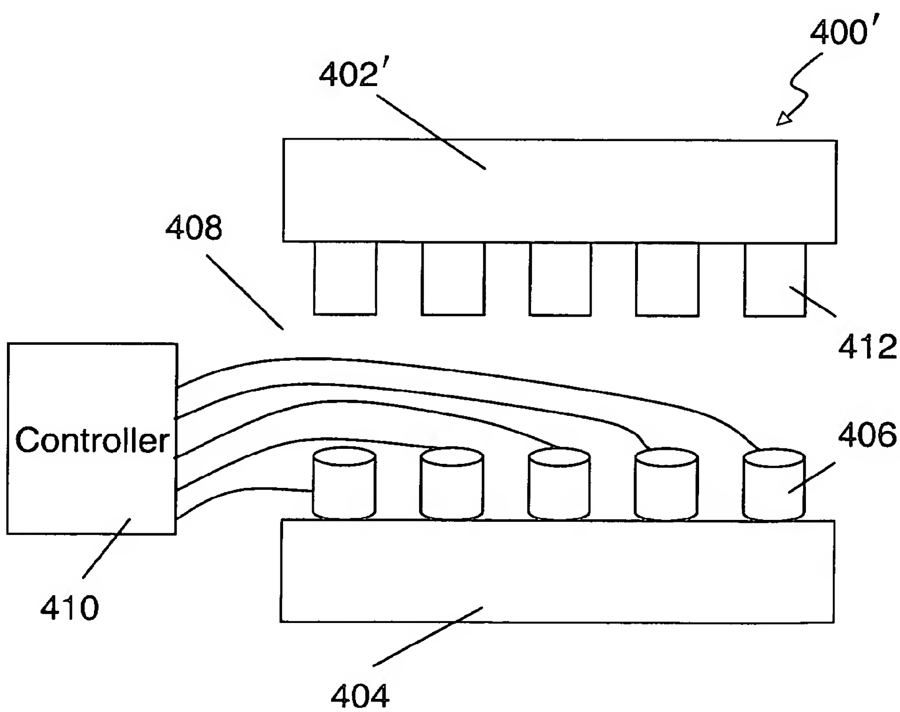
400′
402′
408
412
Controller
406
410
404

FIG. 15

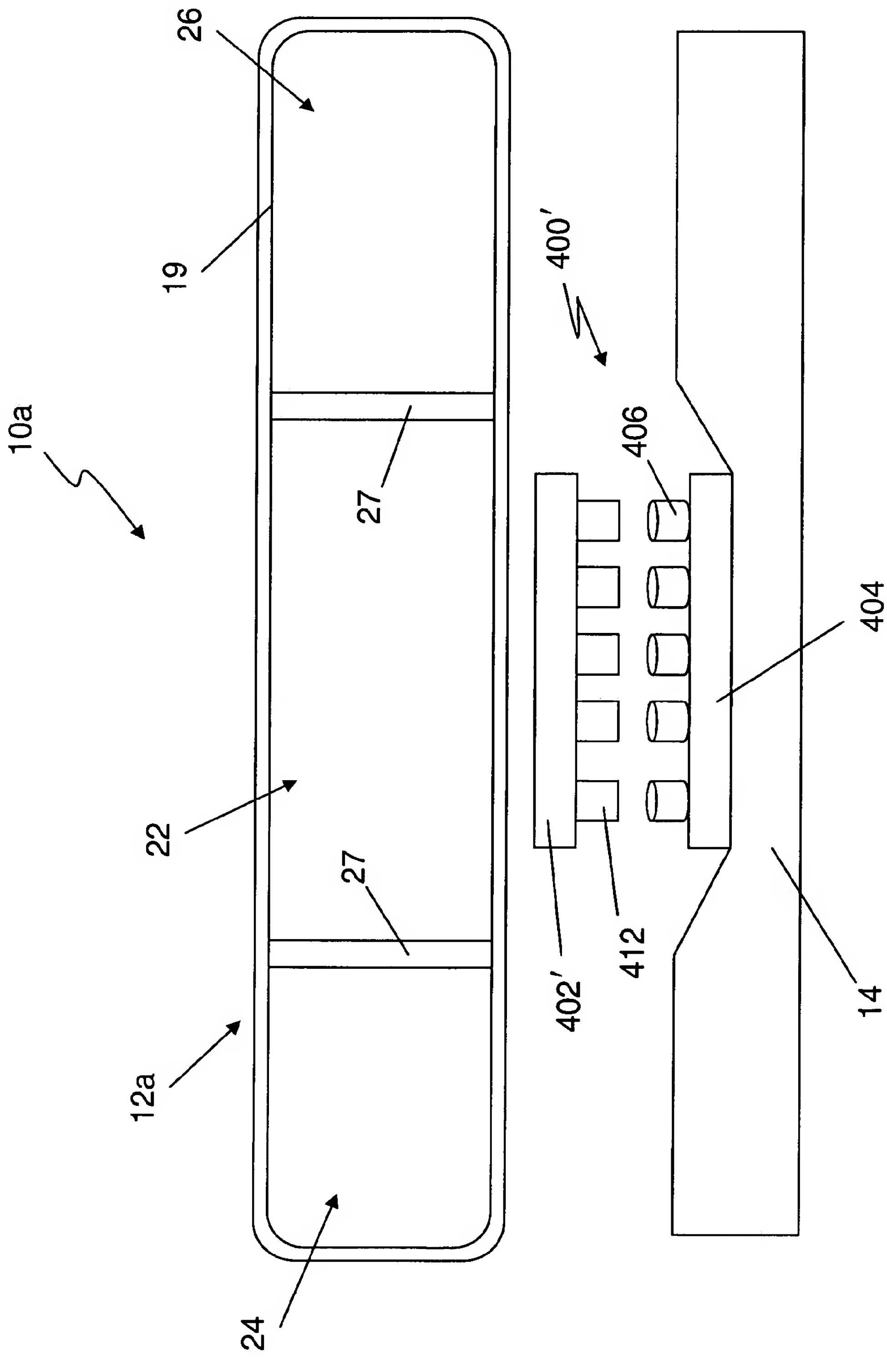

FIG. 16

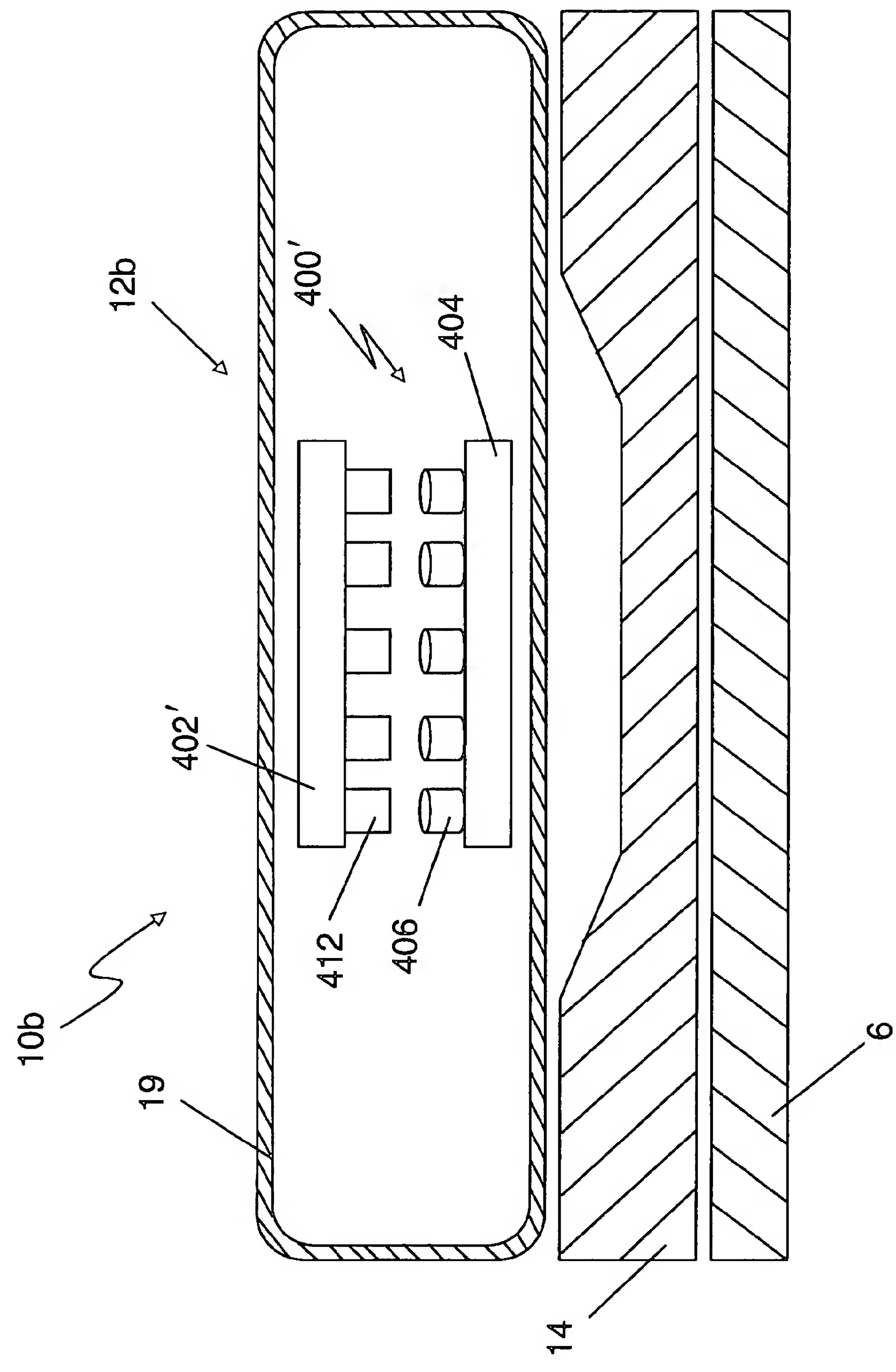

FIG. 17

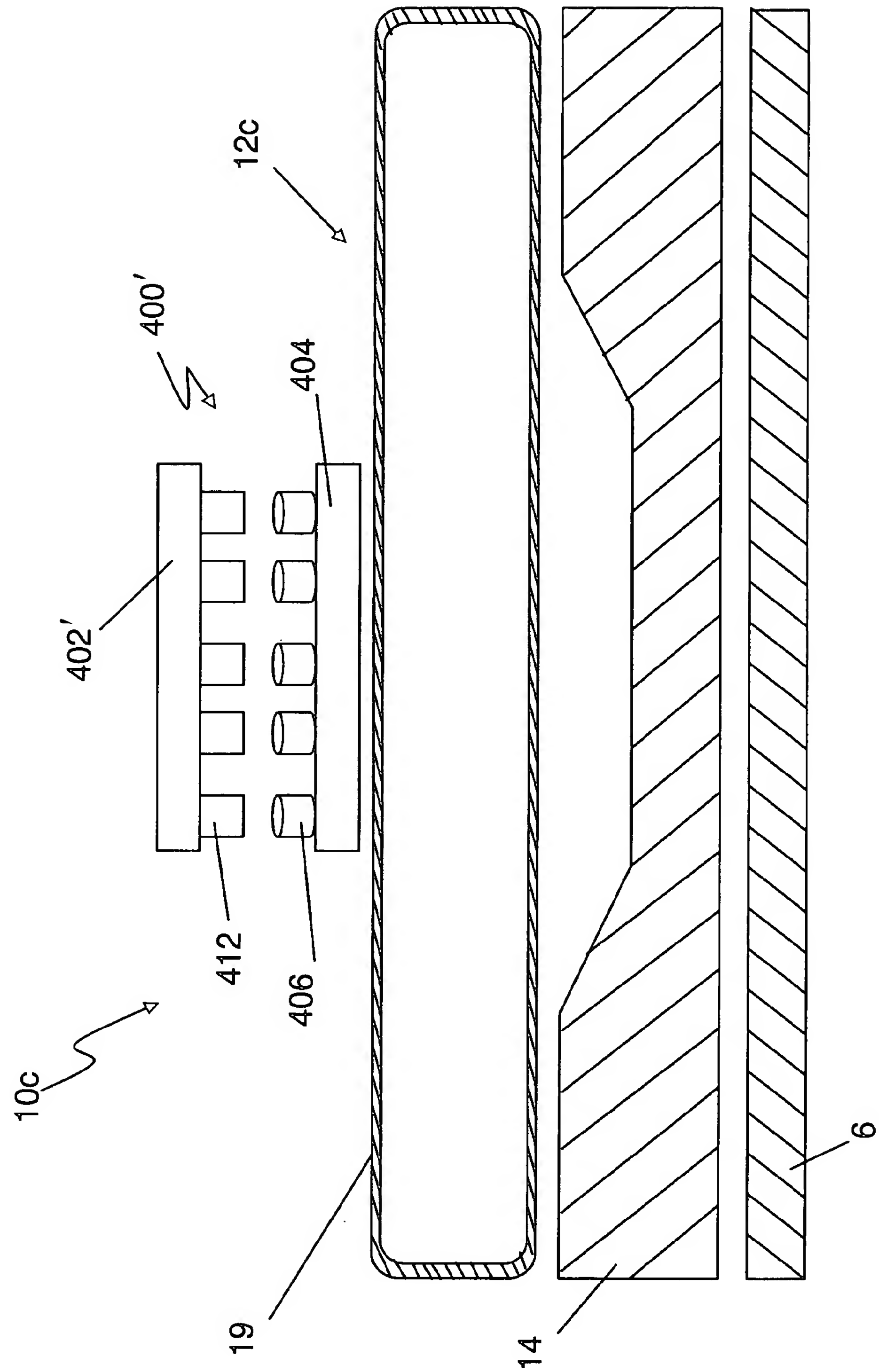

FIG. 18

SEAT FORCE SENSOR
Inventors: Andrew F. Skinner et al.
Serial No.: Unknown
Attorney Docket: 8266-1075

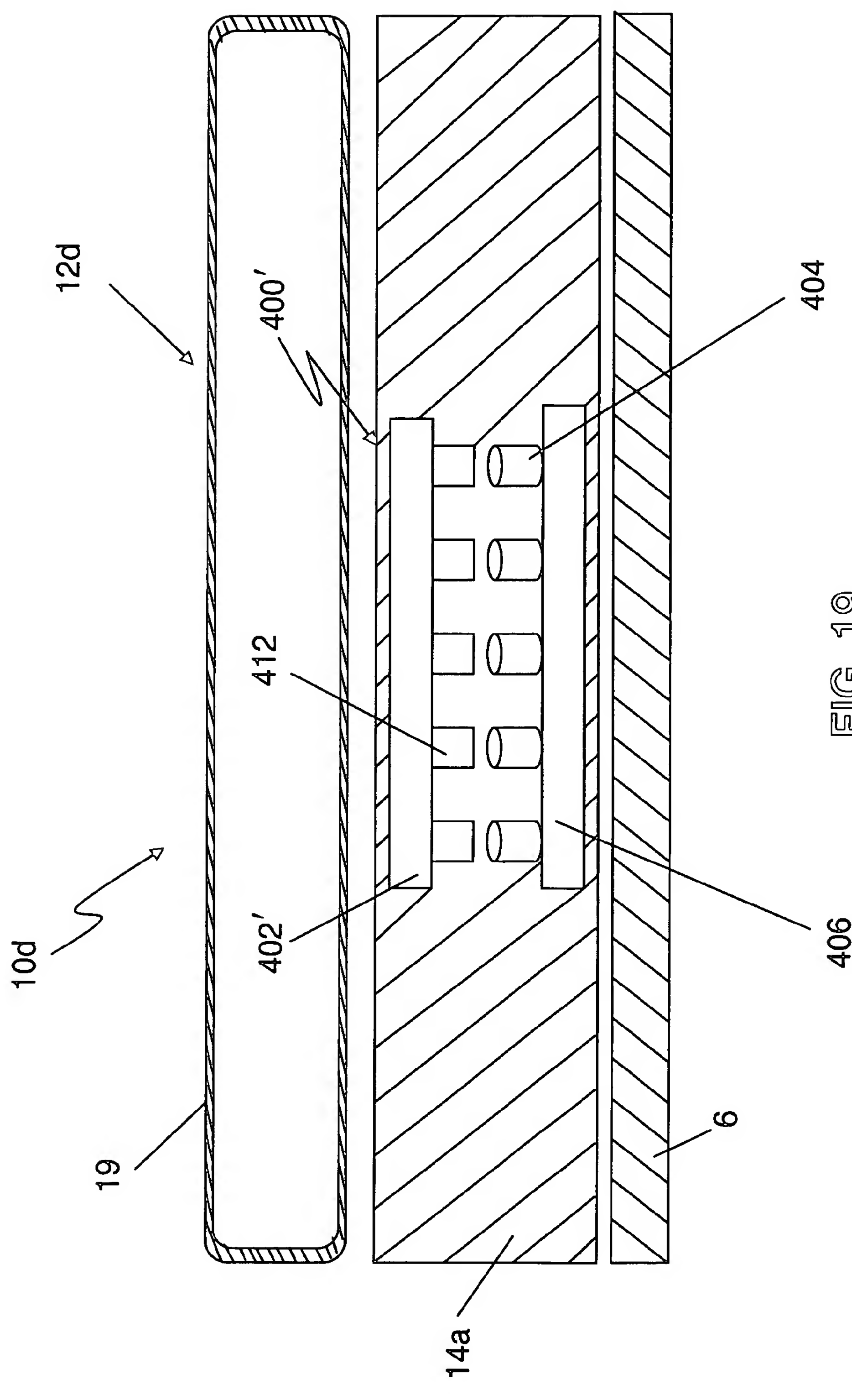

FIG. 19

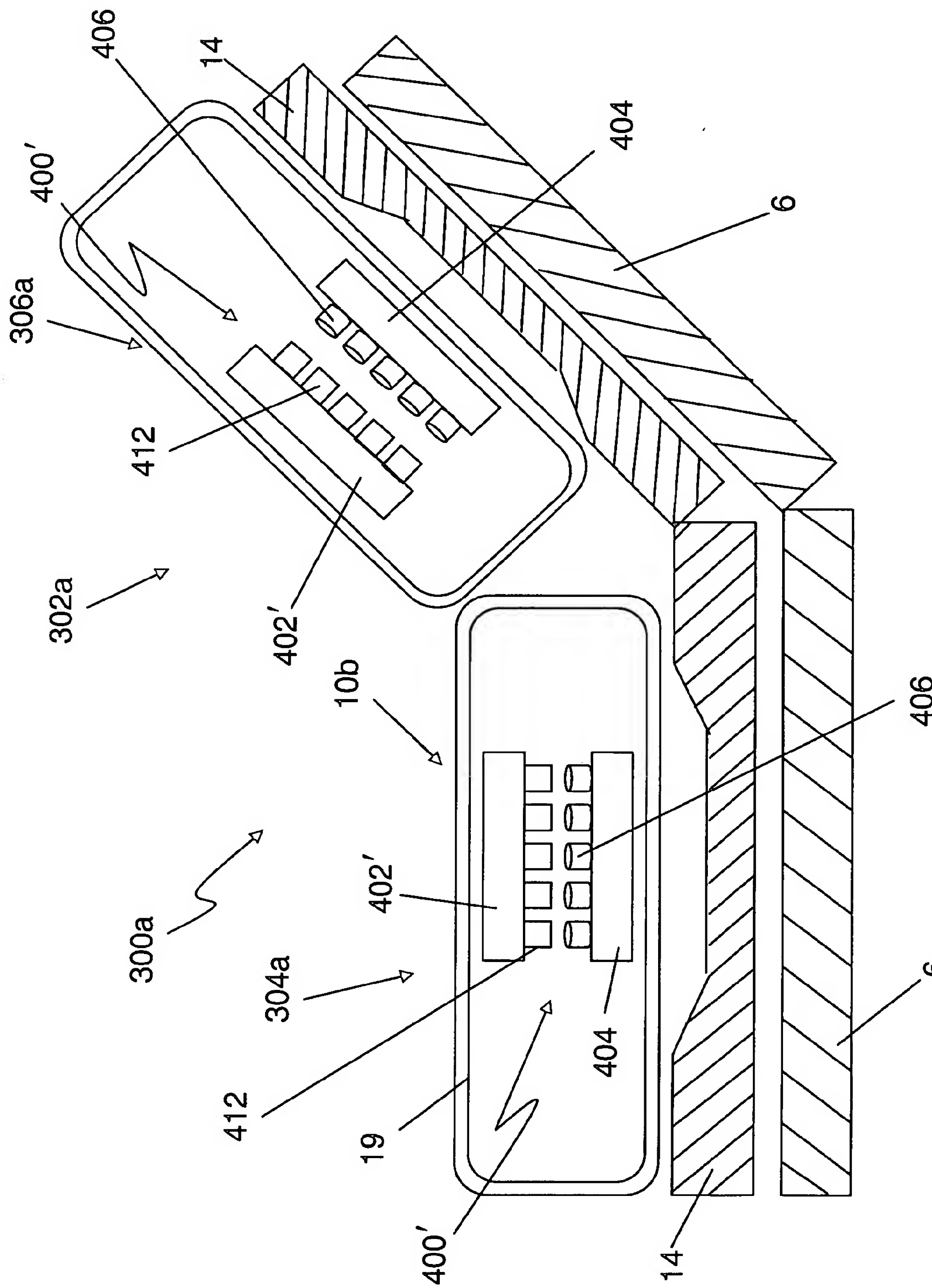
406
14
400′
404
6
306a
412
302a
402′
10b
406
300a
304a
402′
412
19
404
6
400′
14

FIG. 20

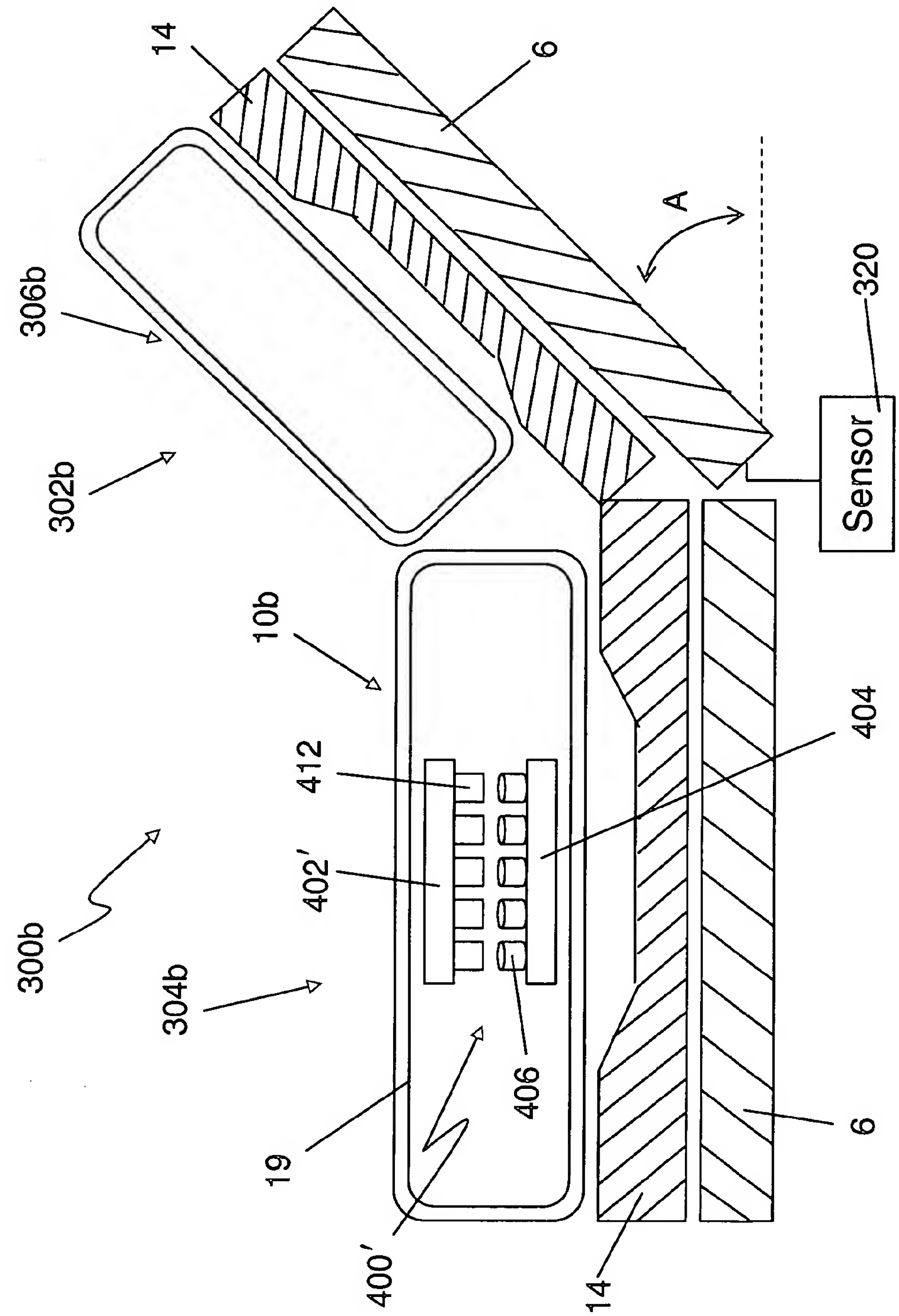
14
6
306b
302b
A
320
Sensor
10b
412
402'
404
300b
304b
406
19
6
400'
14

FIG. 21